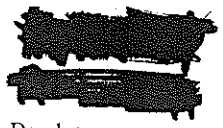

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# MOBILIZING OUTSIDE RESEARCH FOR RATION IMPROVEMENT

DR. TRESSLER

RESEARCH and development work of the Quartermaster Food and Container Institute is of three general types: (1) that carried out by our technologists, chemists, nutritionists, and bacteriologists in our own laboratories, located on Pershing Road in Chicago; (2) work done gratis in cooperation with and in various food packing plants, industrial firms, universities, institutions, etc.; (3) studies carried out under contract in the research laboratories of universities, experiment stations, Government institutions, commercial consulting and testing laboratories, and in industrial plants and laboratories. The research and development work included in (1) and (2) has been adequately covered in numerous articles published previously, and consequently will not be considered here.

However, the reasons why much of the research and some of the development work of the Institute is "farmed out" under contract has not been explained recently. Further, few outside of the Institute are acquainted with the extent and scope of this "external program" as it is called. Consequently, a review of this contract research will be helpful in obtaining a complete picture of the entire research and development work of the Institute.

## WHY SOME RESEARCH IS FARMED OUT

The research and development problems which are "farmed out" are of four types:

1. research work of a highly technical nature requiring specially trained personnel not available in the Institute or in industry, e.g. research on the browning reaction;
2. work requiring special facilities and equipment not available at the Institute or in industrial laboratories, e.g. research on yeast dehydration;
3. special studies which require materials of a type or quality which cannot be obtained in Chicago or vicinity or in food packing plants, eg. special varieties of freshly harvested green peas and green beans;
4. researches on special ration items not now available and not likely to be of sufficient importance in the civilian economy to be of interest to any large food packing company, e.g. dehydrated sweet potatoes.

As a rule, this work is placed under contract in either universities or state experiment stations. However, where other Government agencies, as for example, the United States Department of Agricul-

ture's Regional Laboratories, have better facilities and specially trained personnel, funds may be transferred from the Department of Defense to make possible the conduct of research by such organizations. In a few instances where consulting laboratories have special facilities or personnel with the type of training desired, the contract may be awarded to them.

Some researches, usually of a technological nature, are placed under contract with the laboratories of industrial companies. In many instances, this work is undertaken on a gratis basis; in others, the funds granted are limited to the cost of special materials and equipment required for the work; in some instances the contract covers the entire costs.

## MEAT AND MEAT PRODUCTS

Ration items containing meat are dollar-wise of more importance than other kinds of foods purchased by the Quartermaster Corps. Further, most of the ordinary preserved meat products now being packed commercially do not entirely meet the characteristics required by the Military. For these reasons, more research contracts are placed in the field of animal products than in any other.

The research problems which deal with the canning of ration items containing meat are concerned with improvement of the texture and flavor of the canned product. Means of reducing either the temperature or the time of processing are being studied as one approach to solving the problem. It is hoped that it may be possible to more accurately specify the exact process to be used in sterilizing canned meat items so that the process used commercially will be shorter and result in a product of better quality. Means of controlling spore germination are also being studied. The use of high-temperature short-time processes for meat (e.g. 16 minutes at 315 degrees Fahrenheit for 300 x 308 cans) are being tried in the hope of finding processes which will permit sterilization with less deterioration of texture and flavor. The use of high frequency dielectric treatment for processing meat, particularly ham and luncheon meats, is being studied at the American Meat Institute Foundation Laboratories in an effort to develop a process for sterilizing canned meats in very short periods of time, and without the resultant deterioration caused by the slow penetration of heat which takes place during ordinary sterilization of canned products with steam under pressure.

As yet, no one has determined how to dehydrate meat without effecting a marked change in its flavor and texture. Moreover, dehydrated meat deteriorates during storage, particularly if held at temperatures of 90 degrees Fahrenheit or higher. Studies are being carried out to obtain fundamental information on the nature of the



histological changes which occur during meat dehydration by various processes. Further, the chemical and other changes which occur in the proteins of beef and pork during dehydration, and subsequent storage, are being followed in an effort to obtain basic information which will indicate improvements in dehydration processes.

## CEREALS AND BAKED PRODUCTS

Studies of the stability of prepared cake and other mixes have indicated that these products must contain very little moisture if they are to be stable, when stored at 100 degrees Fahrenheit for more than a month or two. This information has indicated a need for a means of dehydrating wheat flour to a low moisture content without notable change in its properties. Work in this field is being undertaken at the University of Denver. Flour itself slowly deteriorates, particularly if the moisture content is high. For this reason, the storage changes which occur during the storage of flour at various temperatures are being studied at the University of Minnesota. The most difficult problem of the cereal chemist is the prevention of the deterioration of baked products through starch crystallization—commonly known as staling. Fundamental work on the changes occurring in starch-water systems using X-ray spectra are being carried out at Northern Regional Research Laboratory in an endeavor to determine some of the fundamental causes of staling. Particular consideration is being given to the changes in canned bread, an item of great potential value in military feeding. Fundamental work on the chemistry of staling, with critical attention to the formation of starch crystals and related phenomena, is also being carried out at the University of Minnesota and at the University of Nebraska.

## CONFECTION STUDIES

Many confections resemble baked products in that they become stale and unpalatable during long-continued storage. As a rule, the higher the temperature the more rapid the staling. For several years work has been in progress at the Georgia Agricultural Experiment Station to study various phases of refrigeration when applied to nuts, candies, and other confections. This work has clearly indicated the great value of low temperatures for preventing undesirable flavor and texture changes in these products during prolonged storage.

Unfortunately, operational rations are seldom, if ever, refrigerated. For this reason, the use of other means of preventing the staling of the confections in use in Army rations is now being studied at this experiment station. Specific lines of investigation are:

1. use of humectants and their relationship to stabilized moisture content;
2. use of antioxidants and their effect on retarding staling and rancidity;

3. means of protecting nut ingredients from staling, development of off-flavors and other deteriorative changes in confections.

## FRUITS AND VEGETABLES

Most of the research work carried out on fruit and vegetable products under contract is concerned with dehydration. Nearly all dehydrated vegetables and fruits are of high quality when freshly prepared; however, very few will stand storage even for two or three months at 100 degrees Fahrenheit, a distinct handicap to military use overseas. For this reason, extensive work will be necessary to determine means of dehydrating and packing these products so that they will be acceptable for military feeding in remote theaters of operation.

The vegetable and fruit dehydration work now in progress under contract is concentrated on the following products: potato granules, diced potatoes, sweet corn, green beans, green peas, sweet potatoes, lima beans, peaches, and apricots. These have been found to be the products most acceptable to the fighting man.[1] Consequently, all contracts for research work on fruits and vegetables are placed at state agricultural experiment stations. Facilities for experimental dehydration and farms where considerable quantities of fruits and vegetables of known quality and variety are grown are available at the stations selected.

## DAIRY PRODUCTS

Further improvement of the flavor of dry whole milk is high on the list of Institute research and development objectives. Three universities are already deep in the complicated problems involved.

The University of Minnesota has extensively investigated the effect of pre-heat treatment of fluid milk on the flavor and keeping quality of powder. The results of these studies, broadly stated, indicate that short-time, high-temperature heat treatment produces more stable milk.

Pennsylvania State College has studied chemical changes resulting from heat treatment of milk and has sought methods of eliminating the rough or powdery characteristics of reliquefied milk. Adjustments of the acidity and ion exchange treatments appear to reduce the roughness of reliquefied milks—a promising clue to improvement.

The University of Wisconsin is conducting a more basic study of the changes in the milk proteins resulting from the dehydration processes, and in this connection is studying particle size as a factor in dispersibility and stabilization.

Reliquefying dry milk to a beverage has long been a troublesome problem, but in the past it has been overshadowed by the problem of flavor deterioration. When dry milk is used in field areas where

[1] Variety, freshness, and maturity are important factors in determining quality of these products.



mechanical equipment for reconstitution is not available, this problem assumes primary importance. The Quartermaster Food and Container Institute is currently investigating ways to increase the ease of reliquefying dry whole milk, and in addition to the above has contracts with four universities to study separate phases of this work.

Washington State College is under contract to study the effect of processing procedures involved in spray drying of milk on the ease of reliquefying the dry milk.

Ohio State University is studying the influence of fat on the reliquefying properties of dry whole milk.

Purdue University is under contract to investigate the influence of additives such as surface-active agents, stabilizing salts, and sugars on the reliquefying properties of dry whole milk.

The University of Wisconsin, as previously mentioned, is investigating particle size in relation to reliquefying properties of milk powder.

Some of these investigations, although undertaken less than a year ago, show considerable promise of results which may be translated into practical application to the problem.

Studies are also being undertaken in an endeavor to obtain evaporated milk of high stability which will not require turning during storage.

Fundamental studies of the fractionation of the fats of butter are in progress at the University of Wisconsin. It is hoped that this work will indicate means of preparing a special butter which will retain its consistency even under tropical conditions.

## STERILIZATION BY IRRADIATION

Recent work conducted at the Massachusetts Institute of Technology and in other laboratories has indicated that foods can be sterilized by either cathode or gamma rays without the cooking of the food which occurs when perishable products are sterilized by heat. Theoretically, the use of such sterilization procedures will result in products having the texture, flavor, aroma, and color of the raw product. If such procedures are economically practical and the sterilized products wholesome and otherwise desirable, they may indicate great improvements in the quality of many ration items. This research may apply to all perishable foods.

Relatively little radiation is required to destroy insects, larvae, and eggs which may infest certain food products as compared to the treatments needed to kill bacterial spores. Irradiation may therefore be a very simple and practical way to treating packaged cereal and other products which are subject to insect damage. The findings made under this research may be applicable to both food and food packaging problems.

Because of the highly intriguing possibilities of the use of these types of irradiation in food processing, fundamental work in these fields will be undertaken at the Massachusetts Institute of Technology.

### OTHER FUNDAMENTAL RESEARCH

In addition to the work outlined above, most of which is concerned primarily with the improvement of certain specific ration items, a considerable amount of fundamental research is being undertaken in an endeavor to improve the storage life of all foods containing proteins and reducing sugars. Since 1946, the Institute has supported research work on the fundamental chemistry of "non-enzymatic browning" at three universities. At the time these contracts were set up, it had already been recognized that reactions of reducing sugars and amino acids contribute significantly to discoloration of foods and to the development of off-flavors. Those who set up the Quartermaster research program felt that an understanding of the chemistry of the browning reaction might lead to better control of this process which occurs in a wide variety of food products and is responsible for great economic losses due to discoloration, flavor changes, and decrease in nutritive value.

At Ohio State University, Professor Wolfrom and his assistants have employed the model system of the amino acid, glycine, and the reducing sugar, xylose, in their studies. The naive interpretation of the reaction as a carbonylamine interaction of the Schiff base type, in which water is formed by combination of the oxygen of the carbonyl with hydrogen of the amine, has been shown to be too simple. This group has found that both coloration and carbon dioxide formation follow the same curve when the rate of carbon dioxide evolution and the rate of coloration are plotted against the pH of the reaction medium. Four definite regions in the curves are evident: (1) strong basic catalysis between pH 6-8; (2) slight basic catalysis between pH 2.5-5; (3) inhibition below pH 2.5; and (4) an upturn at very low pH probably due to heavy furfuraldehyde polymerization.

Using radioactive carbon 14-labeled amino acid, it has been proved that the carbon dioxide involved in the reaction, originates in the carbonyl group of the amino acid. Carbon dioxide is evolved either in the presence or absence of oxygen, but in the presence of oxygen (air) the sugar can cause degradation of an excess of glycine.

In some of this work, Dr. Hurd, at Northwestern University, has used amino acids containing phenyl groups to act as a tracer nucleus in attempting to follow the course of the reaction. He has developed a working hypothesis that the initial step in browning is a reaction of the reducing sugar with the amino group of an amino acid. This product rearranges to a furfural derivative which reacts with the



initial amino acid-sugar reaction product, a ketose, to form a colored compound.

At Michigan State College, Dr. Speck has turned to low molecular weight aldehydes and amino acids in order to reduce, as much as possible, side reactions. Dr. Speck's findings include:

1. Pyruvaldehyde was identified among the reaction products of glyceraldehyde and glycine. It presumably is formed by dehydration and dealdolization of the sugar molecule, the reaction being catalyzed by the amine group of the amino acid.
2. Furfural type compounds are formed by dehydration reactions of the sugar molecule.
3. Carbon dioxide evolution results from interaction of pyruvaldehyde and furfural type compounds with amino acids.
4. Pigmented material arises as a result of a complex polymerization of all the aldehyde type compounds formed in the reaction mixture.

In addition to these three contracts on the more fundamental aspects of the browning reaction, research work under contract is being carried out at Colorado A and M College in an endeavor to improve the storage life of potatoes and certain other vegetables by modifying the usual blanching (heat treatment to inactivate enzymes) procedure so as to extract substantially all of the reducing sugars prior to dehydration.

Another problem concerned with the stability of foods is the work being carried out under contract at the Mellon Institute for Industrial Research in an endeavor to improve the storage life of active dry yeast at temperatures above 90 degrees Fahrenheit.

In addition to the projects concerned primarily with studies of food stability are the studies of food spoilage and spore germination being undertaken at the University of Chicago and the University of Texas. More fundamental data relative to the conditions under which food spoilage may occur are necessary to insure the preservation of cheese spread and canned bread.

### FOOD ACCEPTANCE RESEARCH

Outside contract research in the food acceptance area is following two main channels. The first is the development and evaluation of methods, a field in which acceptance has been notably weak. One contract, now in its second year, is developing rating scale methods of measuring food preference, with particular emphasis on determination of soldier preferences in the field. Critical review and improvement of methods for use by the small, trained taste panel are the objectives of other current contracts. They provide also for work on the selection and training of panels, statistical tables for rapid interpretation of data, and design of new methods where they are needed.

The second main channel is the investigation of basic factors which affect food acceptance behavior. Studies of appetite and thirst in humans and animals have been underway for some time and are beginning to reveal some of the regulatory mechanisms. For example, it was learned that appetite varies with acuity of the senses of taste and smell. Food intake and feelings of hunger and satiety are altered by exercise and drugs. Thirst and water intake are regulated by sensations in the mouth, by the water content of the body, and by the salt content of the tissues. The role of the central nervous system in regulating water balance is also being studied.

This year the two additional factors of stress and monotony, both of which have been of obvious significance to military feeding, have been brought into the program. A first approach to the stress problem will be investigation, with human subjects, of changes in food preferences under conditions of physiological stress. Since it is realized that the subject of monotony is an elusive one, the first year's work in this area will be devoted to definition of the problem and the design of critical experiments.

## NUTRITION RESEARCH

For several years, the Biochemistry Department of the University of Wisconsin has been engaged in studies to determine whether or not the operational rations, particularly the Combat Ration, possess all of the vitamins and amino acids required for the proper nutrition of the fighting man. Recently, this work has been extended at that institution by the use of monkeys as experimental animals. At Cornell University, the nutritional adequacies of the 5-in-1 and Combat rations are being studied using chickens. Some work is also being carried out at the Emory W. Thurston Laboratories of Los Angeles to determine the effects of sub-marginal, marginal, and high intake of vitamins on adjustment to low environmental temperature.

A comprehensive project involving the study of protein utilization of the ration on limited caloric and water intake is in progress at the New York Medical College.

Work is also being undertaken at the Bureau of Human Nutrition and Home Economics to obtain data concerning the losses of fat and other nutrients which occur during the handling, cooking, and serving of beef.

## CONTAINER RESEARCH

In addition to the extensive research program on foods and ration items, much work is also being undertaken to obtain basic information concerning many types of containers. At the Forest Products Laboratory, fundamental data is being obtained concerning the relationship between the quality of the fiberboard used and the strength of the containers which can be made therefrom.



At the Georgia Agricultural Experiment Station the exchange of moisture between components of the 5-in-1 and Combat rations when stored at selected temperatures is being studied. This work also includes a consideration of the exchange of odors and/or flavors between the components of these two rations; the effect of packaging on the exchange of moisture, odors, and flavors between dehydrated products that are components of these rations is being studied under various storage temperatures and humidities. Another important project is that concerned with the study of the use of quarter-pound tin per base box plate for packaging ration items. A further project concerned with tin containers is underway with the objective of developing a special snap-open 1½-ounce jam can which can be easily opened in the field with gloved hands. The difficulty with previous closures has been the time required for opening and also the hazard of cut fingers.

At the University of Texas, a very comprehensive study designed to obtain fundamental data on stresses and strains exerted on various types of containers used for Quartermaster supplies is being projected.

At a commercial Philadelphia laboratory, certain of the present methods of packaging are being evaluated to determine whether or not the existing military performance standards are adequate or unnecessarily severe in the light of actual field conditions.

## CONCLUSION

From the foregoing account, it will be seen that the research work, carried out for the Institute under contract, comprises a total of approximately 100 different studies in progress in a considerable number of our leading universities, experiment stations, and laboratories. In general, this external research program is of a more fundamental nature than that carried out in the Institute laboratories—the latter being comprised principally of the more urgent technological studies usually designed to effect certain desired improvements in specific ration items. It is believed that the two programs are well coordinated and mutually supplement each other.

DENT

Thank you, Dr. Tressler. Are there any questions regarding Dr. Tressler's talk? To begin with, I would like to ask one myself. What is the procedure, Dr. Tressler, for letting contracts?

TRESSLER

It is a bit complicated and protracted. From the time we start considering a contract until we actually get it signed and sealed, it takes at least four months. Many things interfere with rapid progress. In some instances, we may spend time defining a problem, or we may be

told of a problem by the Research and Development Division in Washington only to find on checking our resources that we either lack the personnel, or the properly trained personnel, or the equipment to carry it out. We must then look around, talk with the various National Research Council committees, in some instances, with your own Associates committees, and consider the various suggestions as to where the work might be done. The difficulty often is that we usually wind up with from two to four possible places. Then we send someone out to see what the facilities are at the institutions proposed. Those of you who have been through the exacting task of placing contract work will recognize the dilemmas. Not more than half of the places that have the facilities are interested in doing the work. That narrows it down sometimes to only one place. Thereupon we may have to use a considerable amount of argument to get this one and only institution to consider the project. However, once we find they are interested, discussion follows immediately and a plan of research is written up, a contract proposal is put in, and the goal—a contract—is then in sight.

You will be interested to know that we let contracts on a cost basis. We determine the special equipment that might be needed, the personnel costs, and cost of the materials. The total becomes the cost of the contract. No contracting agency makes any profit on its investigations as such. If applicable findings are produced, everyone profits, of course.

Perhaps I should emphasize that the institution that undertakes work for us does not take any risk. They merely assure us that they will carry out the work as indicated. If they run out of money, we either must put up more money to have the work continued, or else hold it in abeyance until more money is forthcoming.

After the contract proposal—with the estimates and all other pertinent data included—is written up, it is sent to Washingon and passed on by fiscal, by legal, and by a few other agents of the Department of Defense. If no flaws are found in the contract proposal, it is approved, the contract is drawn up by the legal department, signed by the proper parties, and then the money is made available. It is perhaps not too surprising that all this takes anywhere from four to eight or even nine months.